Chickaloon Village Traditional Council

2021 Preliminary Fleet Electrification Report

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Executive Summary

The department was asked to explore and report on current options of fleet electrification, up to and including feasibility of establishing a small fleet of electric vehicles (EVs). This was to include the vehicles themselves, charging stations, renewable power generation infrastructure, and any other noteworthy equipment which may be necessary to maintain and operate such a fleet. Electrification of transportation is widely seen as beneficial because it presents an opportunity for consumer cost savings, increased local jobs and business, localized benefits of transportation expenditures, improved public health and environmental outcomes, and innovation in and modernization of the electric utility and transportation sectors. The purchase price of current offerings for commuter type vehicles range between $36,000 and $170,000 depending on desired range and features. Trucks range between $40,000 and $140,000. Transit type vehicles are only available from post-production electric retrofitting entities, and price varies greatly depending on which internal combustion engine vehicle is supplied to the retrofitter. Operating costs of electric vehicles is perhaps the most attractive aspect of an electric fleet. Electric vehicles cost much less per mile than their internal combustion or hybrid electric vehicle counterparts. Partially due to the lower cost of electricity per mile versus fuel, and partially due to fewer moving parts and lower maintenance costs. When considering lifecycle costs, which includes purchase, operation, and maintenance costs, electric vehicles are typically less expensive than their traditional counterparts.

EV chargers vary greatly. Some are plugged into a standard 110-volt wall outlet and takes a day or more to fully charge an EV, while others use 220-volt “dryer” outlets and can charge an EV in as little as 8 hours. Fast chargers are standalone purpose-built chargers which must be installed by a certified electrician and are typically located on their own either inside or outside of a building. These chargers can typically bulk-charge (to 80%) most vehicles within an hour. While the fastest fast chargers have twice the charging throughput capability of those without batteries, they must be kept inside to avoid damage to the battery. In addition, maximum battery input also depends on the vehicle's maximum charge capacity.

Ambient temperature has a large impact on the range of electric vehicles. A rule of thumb with electric vehicles in our climate is only count on half the battery capacity and vehicle range claimed by the manufacturer when temperatures fall well below zero Fahrenheit. This is primarily due to the need to use battery power to keep the vehicle and batteries onboard warm. The best way to combat this is to provide a warmed parking space where the vehicles can be kept at maximum battery level and warm before they are driven. While the range does decrease, modern EVs typically perform well in cold weather, with similar or better handling than comparable models of internal combustion engine (ICE) vehicles. Most EVs outperform ICE vehicles for cold weather starts and near-instantaneous cabin heating.

Electric vehicles are not completely without environmental impact. Power producers are still generating electricity with fossil fuels to charge the vehicles, and minerals need to be mined to produce the vehicles. Carbon emissions from the operation and charging of EVs on Matanuska Electric Association's fossil-fuel-heavy resource mix results in about half the carbon emissions as compared to fueling a comparable traditional vehicle. As the grid decarbonizes, with more renewable energy on the system, the emissions benefit from switching to EVs grows.

Suggestions from the Department

Short Term

-If the Tribe wishes to procure an electric vehicle for each department, indoor storage needs to be provided or expect the usable range of the vehicle to decrease by about 25% at 32°F and halved on the coldest days.

-Current VW settlement funds allow the installation of 1-3 Flo Universal Fast Charging stations around our campuses

Long Term

-Having storage is key for the long term goal of achieving the most cost effective and energy efficient fleet that we can operate

-Generate enough renewable energy to power the fleet, whether that's happening on campus or off campus

-Replace as much of the fleet as possible with EVs having accounted for special use vehicles for longer trips until statewide EV charging infrastructure is more robust

Introduction

The department was recently asked to explore the possibilities of Tribal fleet electrification. The initial goal of the project was to determine the feasibility and potential costs of procuring commuter-type vehicles for departmental needs/errands, a school van/bus type vehicle, charging stations, and any other infrastructure required for the normal operation of the vehicles therein. The department was also asked to explore the potential for providing electricity for charging with co-located solar panels or wind turbines.

EV Primer

The transportation sector has begun a transformation, with rapid growth of electric vehicle sales in recent years and sales forecasts, investments, and manufacturing plans all indicating EV technology is the clear leader for light-duty vehicles. Life-cycle costs for light-duty EVs are commonly less than their internal combustion engine vehicle counterparts, even though the purchase price is frequently higher. Vehicle manufacturers are also investing in battery electric models for medium- and heavy-duty vehicles, where the technology can be a good fit, however, technologies like hydrogen fuel-cells are also being explored for heavy-duty and long-range vehicles.

Many of the vehicles detailed in this report are still in the pre-production phase of development. Many manufacturers are seeking to reduce charge times by increasing charge rates before production, or even through software updates post-delivery. Some report more realistic assessments of battery charge times by indicating the charge time to 80% capacity, as the charge rate up to that point is often much faster than the charge rate for the remaining capacity. Others report seemingly unrealistic charge rates. Thus, the charge times indicated below for unreleased models may vary to different extents between manufacturers.

Most current electric van offerings cater to cargo fleet markets. Most of the van-type vehicles reaching the market soon are aimed at securing contracts for delivery fleets belonging to Amazon, USPS, and the like. These vans are purpose-built to provide the maximum volume of cargo and hence are not offered with seats as the passenger van type vehicles can be designed with a smaller, more aerodynamic footprint. Passenger designs aren't available just yet but are coming in the next few years. Currently, the best way to procure electric transit vehicles is to buy an internal combustion engine production vehicle and pay for a conversion. A few companies in the U.S. specialize in such conversions, and some of their offerings are detailed in this report.

Potential Commuter Vehicles

Tesla Model 3

Available: 2017

Price: $39,990-$58,990

Range: Up to 360 Miles

Drive Type: RWD & AWD

Passengers: 4

Minimum Charge Time (80%): 30 Minutes @ 150kW

Ford Mustang Mach E

Available: 2021

Price: $42,895-$64,995

Anticipated Range: Up to 305 Miles

Drive Type: RWD & AWD

Passengers: 4

Charge Time (80%): 30 Minutes @ 150kW

Chevy Bolt

Available: 2017

Price: $36,500-$41,700

Range: 259 Miles

Drive Type: FWD

Passengers: 4

Minimum Charge Time (80%): 70 minutes @ 150kW

Lucid Air

Available: 2021

Price: $77,400-$170,500

Range: Up to 520 Miles

Drive Type: RWD & AWD

Passengers: 4

Minimum Charge Time (80%): 44 Minutes @ 300kW

Fisker Ocean

Available: 2023

Price: $37,499-$68,889

Range: 250-340 Miles

Drive Type: FWD & AWD

Passengers: 4

Minimum Charge Time (80%): 30 Minutes @ 150kW

Potential Trucks

Tesla Cybertruck

Available: 2023

Price: $39,900-$69,900

Range: 250-500 Miles

Drive Type: RWD & AWD

Passengers: 5

Minimum Charge Time (80%): 44 Minutes @ 250 kW

Tow Capacity: 14,000 lbs

Atlis XT

Available: 2023

Price: $45,000-$69,000

Range: 300-500 Miles

Drive Type: AWD

Passengers: 3-6

Minimum Charge Time (100%, theoretical): 15 Minutes @ 500kW (Alleged)

Towing Capacity: 35,000 lbs

Rivian R1T (2022 Motor Trend Truck of the Year)

Available: 2023

Price: $74,075-$79,375

Range: 314 Miles

Drive Type: AWD

Passengers: 5

Minimum Charge Time (100%, theoretical): 170 Minutes @ 160kW

Towing Capacity: 11,000 lbs

Bollinger B2

Available: 2023

Price: $110,000-$125,000

Anticipated Range: >200 Miles

Drive Type: AWD

Passengers: 4

Minimum Charge Time (100%, theoretical):85.2 Minutes @ 100kW

Towing Capacity: 7,500 lbs

Ford All Electric F-150 Lightning

Available: 2022

Price: $40,000-$90,000

Anticipated Range: 230-300 Miles

Drive Type: AWD

Passengers: 5

Minimum Charge Time (80%): 44 Minutes @ 150kW

Towing Capacity: 10,000 lbs

Potential Passenger Vans/Busses

GreenPower EV Star

Available: Now

Price: Quote

Range: 153 Miles

Drive Type: RWD

Passengers: up to 19

Minimum Charge Time: 2 Hours @ 60kW

GreenPower EV Star+

Available: Now

Price: Quote

Range: 150 Miles

Drive Type: RWD

Passengers: up to 24

Minimum Charge Time: 2 Hours @ 61kW

GreenPower EV250

Available: Now

Price: Quote

Range: 163 Miles

Drive Type: RWD

Passengers: 25, 18 standees

Minimum Charge Time: 2.25 Hours @ 120kW

GreenPower BEAST (Battery Electric Automotive School Transportation

Available: Now

Price: Quote

Range: 140 Miles

Drive Type: RWD

Passengers: 90

Minimum Charge Time: 3.25 Hours @ 61kW

Lightning Electric Transit Passenger Van

Available: Now

Price: Quote (Rumored $120,000-$140,000 all-in)

Range: Up to 170 Miles

Drive Type: Depends on supplied van

Passengers: 14

Minimum Charge Time (100%): 120 Minutes @ 80kW

Lightning Electric E-450 Shuttle

Available:Now

Price: Quote

Range: Up to 160 Miles

Drive Type: RWD

Passengers: Up to 24

Minimum Charge Time (100%):180-240 Minutes @ 80kW

Lightning Electric F-550 Shuttle

Available: Now

Price: Quote

Range: 100 Miles

Drive Type:

Passengers: 31

Minimum Charge Time (100%): 120 Minutes @ 80kW

Lightning Electric E-450 School Bus

Available: Now

Price: Quote

Range: Up to 130 Miles

Drive Type: RWD

Passengers: Up to 24

Minimum Charge Time (100%): 120-150 Minutes @ 80kW

Explanation of Charger Types

EV charging is grouped into three different types, Level 1, Level 2, and Level 3 (or DC Fast Charging). In practical terms, Level 1 charging uses standard household current and voltage and can be used to charge EVs over time frames measured in days, or at a minimum, overnight. Level 2 charging uses the same voltage as a typical electric clothes dryer and can be used to fully charge EVs in a matter of hours. Level 3 charging, or DC fast charging, has higher power requirements and can be used to quickly bulk charge EVs, in a matter of minutes to about an hour, depending on the power of the charger and the acceptance rate of the vehicle. The figure below illustrates the EV charger types.

Charger Type	Primary Use	Typical Power Output	Estimated EV Charge Time from Empty (~60 kWh battery)
Level 1	Residential Charging	1 – 1.5 kW	40 - 50 hours
Level 2	Residential and Public Charging	7 - 19 kW	4 - 10 hours
Older Level 3 DC Fast Charge	Public Charging	50 kW	< 1 hour [to 80% charge]*
State-of-the-Art DC Fast Charge	Public Charging	150 kW +	20 minutes [to 80% charge]*

Figure 1 - Representative Operational Characteristics of EV Chargers for Light-Duty Vehicles, from U.S. DOT

A network of charging stations is commonly seen as necessary to permit customer adoption of EVs. A recent review of PlugShare.com indicates sixty-eight charging stations in Alaska, with six of these stations listed as fast chargers. Juneau has a larger proportion of stations relative to other Alaskan communities. For comparison, the U.S. Department of Energy Alternative Fuels Data Center lists over 44,300 publicly available charging stations, of which about 5,400 are DCFC, for the U.S. To get a sense of how fast this sector is growing, a little less than a year ago this site reported 27,329 publicly available charging stations, with 4,000 DCFC. The expansion of electric vehicle charging is happening very rapidly. In Alaska the Alaska Energy Authority, the Alaska Department of Transportation and Public Facilities, several of the utilities, and multiple private businesses and site hosts are coordinating to establish a network of charging stations for the road systems.

Potential Charge Station Options

Freewire Boost Charger

Price: Quote

Charge ports: 2

Onboard Battery: Yes, 160kWh

Minimum Temperature: -4° F

Maximum charge rate: One vehicle at 150kw, two vehicles at 75kw

Input Power Requirements: ≤ 27 kW; 3-phase 100 Amps @ 208 VAC, or Split-phase 150 Amps @ 240 VAC

Payment methods: Credit cards, NFC, MIFARE, FeliCa

Flo Universal Fast Charger

Price: Quote

Charge ports: 2

Onboard Battery: No

Minimum Temperature: -40° F

Maximum charge rate: 100kW (also available in 50kW output variant)

Input Power Requirements: ≤ 54kW 65 Amps @ 480 VAC, or ≤ 108kW 130 Amps @ 480 VAC

Payment methods: RFID card and/or Flo mobile app authentication and payment

Siemens Versicharge

Price: Quote

Charge ports: 1-4 (Depending on variant)

Onboard Battery: No

Minimum Temperature: -22° F

Maximum charge rate: Up to 22kW

Input Power Requirements: Three Phase 22kW 32 Amps @ 400 VAC, 7.2 kW 32 Amps @ 230 VAC Single Phase

Payment methods: RFID card and/or Flo mobile app authentication and payment

Tesla Wall Connector

Price: $550

Charge ports: 1

Onboard Battery: No

Minimum Temperature: -22° F

Maximum charge rate: Up to 11.5kW

Input Power Requirements: 60 amp breaker, 240 VAC Single Phase

Installation Type: Hardwire or NEMA 14-50

Payment methods: None

JuiceBox 40

Price: $569

Charge ports: 1

Onboard Battery: No

Minimum Temperature: -22° F

Maximum charge rate: Up to 9.6kW

Input Power Requirements: 50 amp breaker, 240 VAC Single Phase

Installation Type: Hardwire or NEMA 14-50 plug

Payment methods: None

ChargePoint Home Flex

Price: $699

Charge ports: 1

Onboard Battery: No

Minimum Temperature: -22° F

Maximum charge rate: Up to 12kW

Input Power Requirements: 50 amp breaker, 240 VAC Single Phase.

Installation Type: Hardwire or NEMA 14-50 plug

Payment methods: None

Cold Weather Performance

Ambient air temperature has greater implications for electric vehicles than their internal combustion counterparts. Battery technology has come a long way in the past few decades; however, many issues of yesteryear's technology pervade with modern batteries. As such, temperature plays a primary role in how an electric vehicle performs in a climate like Alaska's.

Internal combustion engines create heat for the cabin space by transferring heat from the engine to a radiator located inside the cabin of the vehicle. In this case, the heat is a by-product of the vehicle's mode of locomotion. That is not the case of for the electric vehicle. Electric vehicles must expend their battery capacity to warm the cabin in addition to, and independent of whatever they expend driving the electric motor to move the car down the road. EV batteries do not produce their optimal voltage or power output unless they are warm. This has an additional effect on range if the vehicle is not warmed before or during driving. A recent study by the American Automobile Association (AAA) showed a 41% driving range reduction at a temperature of 20°F due to using climate controls (Edmonds, 2019). This means only 59 or less miles of usable range out of 100 from the months of October to April. A 2019 study by Consumer Reports showed that three 21-mile trips with an hour and associated re-heating of the cabin between trips reduced effective range of roughly 50% in multiple EVs (Olsen, 2019). Geotab has published results from the largest study of real-world performance, capturing data from 4200 EVs. The illustration below shows the impact of temperature on real-world range (Argue, 2020).

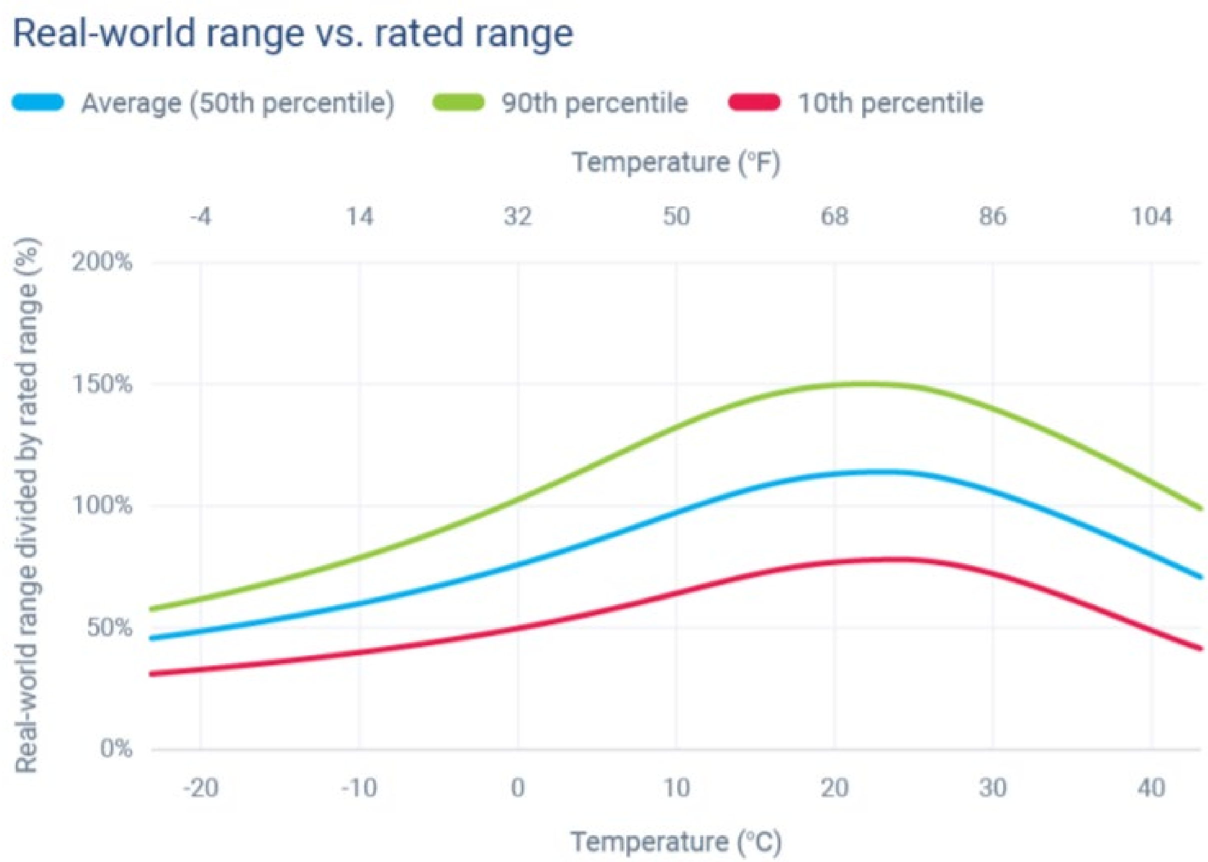

Figure 2 - Geotab's Temperature vs EV Range Impact Graph

One of the best ways to mitigate the range reduction factor of the climate is to reduce the amount of energy the vehicle expends on warming the cabin. This can be done by keeping the vehicles inside a heated space, keeping the vehicle plugged in and warmed using exterior power prior to departure, or both.

Just as the climate effects EV batteries in cold, climate also effects charge stations. Some charging stations use onboard batteries to store extra power between charging sessions to avoid high electric utility demand charges or provide fast charging in areas where 3 phase power is unavailable. These battery-supported charging stations are not recommended for colder climates.

The Freewire Boost Charger for instance, cannot be subjected for a climate lower than -4° F. Freewire charging stations were installed on the Kenai Peninsula in 2021 to help customers defray demand charges and to gather cold-weather performance data.

Onsite Energy Generation

The amount of energy generation required to support even a small EV fleet will take up large spaces. The Tribe takes great care in the beautification of its grounds, and solar farms and wind turbines can be counterproductive in that sense. The department did some quick math to determine the approximate amount of space required for a solar panel field which could support a small fleet of EV's (2 commuter vehicles, and one passenger van/bus). The required space assuming less than 4 hours of optimal solar production time is approximately 24,415 sq. ft or 156 ft by 156 ft.

The department suggests the use of offsite energy generation. Energy generation infrastructure could be located offsite and used to offset the net consumption of the EV fleet by feeding into the grid equal or greater quantities of power than is being consumed by the fleet. This would keep primary campuses which are likely to utilize EV's more open to necessary onsite improvements and beautification. Meanwhile the Tribe's renewable energy projects can be in less conspicuous areas away from places where business is conducted on a regular basis. This would also allow the Tribe to place the locational focus on place of optimal production rather than place of use.

Hybrid Alternatives

Hybrid electric vehicles have been well known since soon after the launch of the Toyota Prius in the late 1990's. Though they utilize an internal combustion engine, hybrid electric vehicles also use a battery to store excess electricity generated by the engine's alternator and braking. This energy in turn can be used to propel the vehicle down the road very short distances, saving gas the engine would otherwise burning. This in effect means a conventional internal combustion engine vehicle with better fuel economy.

More recently, plug-in hybrid electric vehicles (PHEVs) have hit the consumer market. These vehicles are like the standard hybrid but feature a larger battery pack which allows them to travel up to around fifty miles on battery power alone. They can be plugged in to charge when it is convenient, but if more range than the battery has is required the internal combustion engine starts up for the rest of the drive. These vehicles offer an interesting solution for our climate as both options are built into the vehicle and shorter trips can be done without burning gasoline. Unlike fully electric vehicles, they are not limited by the shortcomings of batteries in cold weather.

Operating costs

Price per mile

The cost per mile of an electric vehicle may be lower than that of internal combustion counterparts, but it is nonetheless a cost that must be considered. Matanuska Electric Association's current rate for electricity is 12.45 cents per kWh for the first 1300 kWh. The cost of power adjustment surcharge is 7.22 cents per kWh. The regulatory cost charge is .08 cents per kWh. The effective rate per kWh, not including flat-rate facility fees, is 19.75 cents per kWh. This means operating cost per mile of the Tesla at 3.7 miles per kWh is 5.3 cents per mile. The operating cost per mile of the Lightning Electric Van at 1.53 miles per kWh is 12.9 cents per mile. A mileage cost for two Tesla's travelling 300 miles per week each and a Lightning Electric Van travelling 500 miles per week is $96.30 ($31.80 for the Tesla's + $64.50 for the Van). When taking the impact of temperature into account in the scenario above, the annual cost of charging the two Teslas is $2,420.94 and charging the Lightning Electric Van is $4,576.34, for a combined "fuel" expense of $6,997.28. Below is a table showing all EVs detailed in this report with operating costs varying based on price per kWh.

Electric Vehicles					
Type	Vehicle	~ Miles Per kWh	Price Per Mile (Cents) Per Price Per kWh (Cents)		
			10	20	30
Cars & SUV's	Tesla Model 3	3.7	2.70	5.41	8.11
	Mustang Mach E	3.41	2.93	5.87	8.80
	Chevy Bolt	3.92	2.55	5.10	7.65
	Lucid Air	4.51	2.22	4.43	6.65
	Fisker Ocean	3.75	2.67	5.33	8.00
Trucks	Tesla Cybertruck	2	5.00	10.00	15.00
	Atlis XT	2	5.00	10.00	15.00
	Rivian R1T	2.17	4.61	9.22	13.82
	Bollinger B2	1.67	5.99	11.98	17.96
	F-150 Lightning	2.29	4.37	8.73	13.10
Transit Vehicles	GreenPower EV Star	1.3	7.69	15.38	23.08
	GreenPower EV Star+	1.27	7.87	15.75	23.62
	GreenPower EV250	0.62	16.13	32.26	48.39
	GreenPower BEAST	0.72	13.89	27.78	41.67
	Lightning Electric Transit Passenger Van	1.53	6.54	13.07	19.61
	Lightning Electric E-450 Shuttle	1.28	7.81	15.63	23.44
	Lightning Electric F-550 Shuttle	0.78	12.82	25.64	38.46
	Lightning Electric E-450 School Bus	1.3	7.69	15.38	23.08

Price Per Mile Comparison to Combustion Vehicles

The Price per mile operating cost of combustion vehicles varies greatly. Fuel consumption of the vehicle, gas prices at the time of consumption, seasonal maintenance, and repair costs all factor into the operating cost per mile. Gasoline and Diesel prices often vary by the week. Alaska averaged $3.70 a gallon for gasoline this year.

To get an idea of the cost range of our existing combustion vehicles, we will explore the price at a dollar under this year's average, the price at average, and the price at a dollar over average. A 2018 Chevy Sonic gets 30 miles of combined driving per gallon. At a price of $2.50 a gallon, the fuel price per mile is 8.33 cents. At a price of $3.50 a gallon, the fuel price per mile is

11.67 cents. At a price of $4.50 a gallon, the fuel price per mile is 15 cents. A 2014 E 450 Passenger van/bus gets 7.1 miles per gallon combined. At a price of $2.50 a gallon, the fuel price per mile is 35.21 cents. At a price of $3.50 a gallon, the fuel price per mile is 49.29 cents. At a price of $4.50 a gallon, the fuel price per mile is 63.38 cents. To compare to the EV scenario discussed above, the costs of two Chevy Sonics, each driving 300 miles a week and a E 450 driving 500 miles a week were calculated. Taking the impacts of temperature into account on the loss of efficiency on these traditional vehicles, the annual costs of fueling the two Chevy Sonics is $4,423.74 and the cost of fueling the van is $15,779.72, for a combined fuel cost of $20,203.46. In this scenario, switching to EVs will save approximately $13,200 per year in fuel costs. This does not include additional savings that are expected from reduced maintenance costs. Below is a table showing current fleet vehicles with operating costs varying based on price per gallon of fuel.

Existing Vehicles					
Type	Vehicle	MPG	Price Per Mile (Cents) Per Price Per Gallon (Dollars)		
			$2.50	$3.50	$4.50
Cars & SUV's	2018 Chevy Sonic	30	8.33	11.67	15.00
	2015 Chevy Sonic	29	8.62	12.07	15.52
	2018 Chevy Equinox	26	9.62	13.46	17.31
	2021 Jeep Renegade	25	10.00	14.00	18.00
	2021 Ford Eco Sport	25	10.00	14.00	18.00
	2011 Ford Escape	22	11.36	15.91	20.45
	2014 Ford Explorer	14	17.86	25.00	32.14
Trucks	2015 Chevy Silverado	18	13.89	19.44	25.00
	2011 GMC Sierra	17	14.71	20.59	26.47
	2017 GMC Sierra 3500 Flatbed	12	20.83	29.17	37.50
	2019 Ford F 350	12	20.83	29.17	37.50
	2021 Ford F550	8	31.25	43.75	56.25
Transit Vehicles	2020 Ford Transit Connect	26	9.62	13.46	17.31
	2013 Dodge Grand Caravan	20	12.50	17.50	22.50
	2021 Ford Transit Wagon AWD	16	15.63	21.88	28.13
	2017 Chevy Express Van	13	19.23	26.92	34.62

Figure 4 - Current Fleet Vehicles Price Per Mile Costs

Price Per Mile Comparison to Hybrid Vehicles

The Tribe is currently considering hybrid combustion vehicles. One such vehicle is the 2022 Ford Escape Hybrid (also available as a PHEV) which gets 41 combined miles per gallon. At a price of $2.50 a gallon, the fuel price per mile is 6.10 cents. At a price of $3.50 a gallon, the fuel price per mile is 8.54 cents. At a price of $4.50 a gallon, the fuel price per mile is 10.98 cents. The 2022 Chrysler Pacifica Hybrid gets 30 mpg (7 passengers, PHEV standard, 32-mile battery only range). At a price of $2.50 a gallon, the fuel price per mile is 8.3 cents. At a price of $3.50 a gallon, the fuel price per mile is 11.67 cents. At a price of $4.50 a gallon, the fuel price per mile is fifteen cents. Below is a table showing potential hybrid vehicles with operating costs varying based on price per gallon of fuel.

Potential Hybrid Vehicles (2022)					
Type	Vehicle	MPG	Price Per Mile (Cents)		
			Per Price Per Gallon (Dollars)		
			$2.50	$3.50	$4.50
SUV's	2022 Ford Escape	41	6.10	8.54	10.98
	2022 Ford Explorer	25	10.00	14.00	18.00
	2022 Jeep Wrangler 4Xe	20	12.50	17.50	22.50
Trucks	2022 Ford Maverick	40	6.25	8.75	11.25
	2022 GMC Sierra 1500	20	12.50	17.50	22.50
Transit Vehicles	2022 Chrysler Pacifica Hybrid	30	8.33	11.67	15.00

Figure 5 - Hybrid Vehicle Price Per Mile Costs

Cost of Maintenance

It is difficult to anticipate how many repairs any particular vehicle will need throughout its lifetime, but internal combustion vehicles have many more moving parts than their electric vehicle counterparts and require services for oil, timing belts, oxygen sensors, spark plugs and other combustion-related components. This means more costs due to repair, downtime of staff, and supplemental transportation. According to the U.S. Office Of Energy Efficiency and Renewable Energy, internal combustion engine vehicles cost approximately ten cents per mile to maintain versus approximately six cents for battery electric vehicles (U.S. Office Of Energy Efficiency and Renewable Energy, 2021). Hybrid and plug-in hybrid vehicles fall respectively between the two maintenance cost extremes. Below is a maintenance cost breakdown graph for light duty vehicles showing scheduled maintenance costs for each vehicle type provided by the U.S. Office Of Energy Efficiency and Renewable Energy.

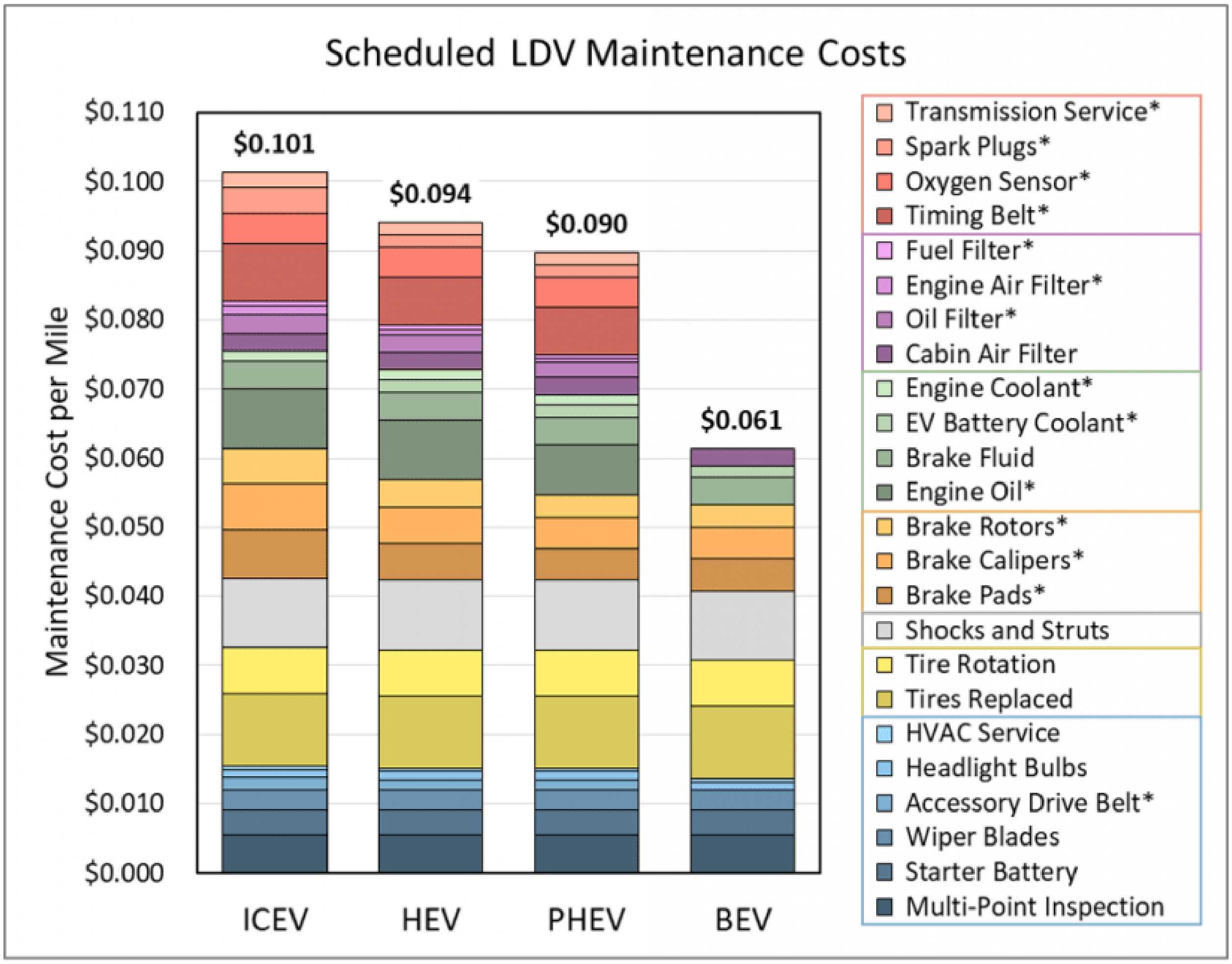

Figure 6 - USOEERE Scheduled LDV Maintenance Costs

LDV – Light-Duty Vehicle

ICEV – Internal Combustion Engine Vehicles

HEV – Hybrid Electric Vehicle

PHEV – Plug-in Hybrid Electric Vehicle

BEV – Battery Electric Vehicle

Storage

Heated storage is recommended for the optimal use of an electric fleet as mentioned above. To appropriately house a small fleet of EVs (2 commuter vehicles, and one passenger van/bus) the department suggests a 40'x40' steel building with a bay door for each vehicle. This would be co-located on the campus where the offices of the primary drivers of said vehicles are. The department approximates the cost of construction of said steel building with insulation and necessary heating apparatus at $250,000.

Environmental Impacts of EVs

Power generation

Though “going green” and electric vehicles have almost become synonymous, it is important to consider and weigh the environmental impacts they have. When we think about electric vehicles, we think plugging in, charging up, and heading down the road without the need for combustion. While it is true that the vehicle itself is not directly using fossil fuels to go down the road, the creation of the power it uses is not be without impact. If the Tribe does not directly power the vehicles with renewables, offset the electricity required from the grid with renewable energy, or generate more renewable power than the fleet is using, then some amount of energy will have to come from the grid. Currently MEA generates 89% of grid power using fossil fuels, with the remaining 11% coming from hydro-electric and independent solar power producers (Reducing costs and promoting a healthy environment for our members, n.d.). A significant environmental benefit of switching to electric vehicles is the lower greenhouse gas emissions, even with the fossil-fuel-heavy mix from the electric grid. In the scenario discussed above, of two Chevrolet Sonics each driving 300 miles per week and an E 450 van driving 500 miles per week, the combined annual carbon dioxide emissions total approximately 43,200 kilograms. If two Tesla Model 3s and a Lighting electric van are used instead of the traditional vehicles, the carbon dioxide emissions total approximately 14,500 kilograms. The emissions reduction of 28,700 kilograms of carbon dioxide from electrification of these three vehicles is a climate benefit. As more renewables are utilized by MEA and the Tribe, this annual climate benefit grows.

Raw Construction Materials

All the EVs entailed in this report utilize lithium-ion batteries. These batteries require cobalt, lithium, and other rare earth elements. The mining of each of these raw materials can have profound effects on the environment. Most of the world's cobalt comes from unregulated mines in the Congo which sometimes use child labor. Lithium most often comes from South America and requires copious amounts of precious groundwater used by indigenous farmers. The rare earth minerals come primarily from China and contaminate water and air with radioactive particulate (Plumer & Tabuchi, 2021). The giga factories in which EV's are produced also consume large amounts of resources and energy themselves due to both their creation and operation as well. All the factors mentioned above are however offset by the lower lifetime use impact on the environment when compared to combustion engine vehicles (Choudhury, 2021).

Funding Opportunities

EVs can have lower lifecycle costs than traditional vehicles however, the first cost associated with higher purchase prices and the cost of electrical infrastructure upgrades is a deterrent to many individual consumers and fleet managers. Recognizing this, and other, barriers, the federal government is supporting vehicle electrification through established and new funding mechanisms, policies, and programs. The U.S. Department of Transportation's (DOT) Federal Highway Administration (FHWA) is seeking to accelerate the deployment of EV chargers on the National Highway System, in support of the Biden-Harris Administration's goal of installing 500,000 new EV chargers by 2030, by partnering with States, Tribes, metropolitan planning organizations, and Federal land management agencies. There are many DOT funding and finance programs with EV eligibilities, some of which are under development from the recently passed Infrastructure Investment and Jobs Act (IIJA). The U.S. Department of Energy (DOE) also has increased the number and type of competitive funding opportunities for vehicle electrification in recent years. The discussion here is intended as a short primer on a few of the opportunities available to Tribes and is not an exhaustive list. Coordination with Federal and State agencies and monitoring for notices of funding opportunities will be critical in the coming months as federal investment is dramatically ramping under the IIJA.

The Federal Lands and Tribal Transportation Program (FLTTP) offers a common set of Federal funding mechanisms for Tribal transportation. Under this umbrella, DOT offers the Tribal Transportation Program (TTP), Federal Lands Transportation Program (FLTP), and the Federal Lands Access Program (FLAP). These programs allow for EV acquisitions and engine conversions for cars and trucks, planning for EV charging, construction, and installation of EV charging to support operational, resiliency, national energy security, and environmental and community goals for freight transportation, and installation of EV charging as part of transit capital projects.

On November 15, 2021, President Biden signed into law the Infrastructure Investment and Jobs Act that includes a five-year reauthorization of federal highweay, highway safety, transit, and rail programs for fiscal years 2022 through 2026. The IIJA is a historic investment in all forms of infrastructure, with $567 billion in resources provided to the U.S. Department of Transportation. Of the funding provided to both DOT and the DOE, just over $50 billion are eligible for EV activities. State agencies, including the Alaska Energy Authority (AEA) and Alaska Department of Transportation and Public Facilities (AKDOT&PF) are coordinating to determine how to best leverage the Federal funding in the IIJA. Much of the EV-specific funding provided through the IIJA will be issued through competitive grants. However, Division J money provides formula funding, approximately $52 million for the State of Alaska, which is specifically to be used to "strategically" deploy EV charging, maintain the infrastructure and to "establish an interconnected network to facilitate data collection, access and reliability". Collaboration with the State to access these formula funds may be a more certain pathway to funding than the competitive grants authorized through other sections of the IIJA.

The U.S. Department of Energy regularly issues notices of funding opportunities through its Vehicle Technology Office which apply to vehicle electrification. Solicitations issued from this office in recent years have provided an opportunity for Tribes to pilot EV technology, establish charging networks, and transition fleets. Monitoring the Department of Energy's Energy

Efficiency and Renewable Energy (EERE) Funding Opportunity Exchange website (https://eere-exchange.energy.gov/Default.aspx) and coordination with the Alaska Energy Authority for larger proposals to these competitive solicitations is advised.

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